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THE UTILIZATION OF AEROPHOTOGRAPHY FOR REVEALING AND ESTIMATING NATURAL RESOURCES

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THE UTILIZATION OF AEROPHOTOGRAPHY FOR REVEALING AND ESTIMATING NATURAL RESOURCES

by

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Aerophotography in the USSR is used for the exploration of the natural resources especially in the areas which were hitherto poorly investigated;,this method increases the efficiency of the work, reduces the interval and the expenses involved with the performance of the examinations. The materials produced by aerophotography are of especial significance in the course of studying the remote and poorly accessible areas similar to the vast desert planes, mountain ranges, massives of tropical and subtropical woods etc.

a/ Geological works

Aerophotography is of great value for the performance of geological works.

Special rational parameters are developed for aerophotography when the latter technique is used for geological mapping. It enables to produce aerophotopictures which reveal a high standard of deciphering properties. For the estimation of the parameters required for aerophotography one ought to take into consideration the landscape peculiarities of the area and also the scale and the task purpose of the geological works. The scale of the aerophotography is chosen with a due account of the scale of the geological investigations and the complexity of the geological structure in the examined area. When the geological mapping is to be carried out at a scale of 1:200 000 the scale of the airplane pictures ranges from 1:25 000 to 1:50 000; when the mapping is performed at the scale of 1:50 000 it varies within the limits of 1:10000 up to 1:25 000.

The time of the year for aerophotography is selected in accordance with the specific features of the landscope (the presence of utmost contrasts in the moistening properties of rocks, the vegetation, the number of clear days with good visibility, the state of the atmosphere etc.).

The daylight hours and the selection of the focal length for the aerophotographic works are determined by the relief of the area. In the plain areas aerephotography is carried out during the early morning or the early evening hours with the use of short focal aerophotodevices (f 100) which permits to stress the forms of the relief. In the mountain areas it is better to perform work during the hours which are close to noon and the focal length should be 200 or more.

For the purpose of revealing areas with multicoloured rocks it is advisable to use a three layer coloured aerophotofilm which sometimes should require filters. In the latter case the basic object of the exploration is to produce a maximum colour division of the rocks. This picture may be somewhat distorted but should be of a uniform character within the limits of a single flight. A spectrozonal film is used in the populated areas or in those which are covered with grass vegitation and where the geobotanical characters play an important role in the course of the diciphering

works. One of the layers of this film is sensibilized to the infrared zone of the spectrum.

The expenses involved with the aerophotographic works when the coloured and the spectrozonal films are required are about 10-20% higher than those done with the white-black films. And, hence, bearing in mind the somewhat higher cost of the coloured aerophotomaterials the coloured aeroplane pictures are frequently prepared from the aerophotofilms in a skipping manner (every other one) and for deciphering one uses the black-white picture as a stereo-pair.

All the aerophotographic works are performed with the aid of special devices which provide the carefully envisaged position of the aerophotopicture and an accurate altitude 'attachment' of the plane during the photographic operation (gyrostabilizing device, statoscope and radioaltitude meter).

The deciphering of the aerophotopictures is carried out in close contact with the land investigations and is performed in three stages: prior to the field studies, during the field works and during the final treatment of the geological materials. The technique adopted in the USSR provides for the land research of the entire territory and is not restricted to the study of single key areas as it is frequently practised in other countries. This approach enables to obtain a more complete evaluation of the area from the viewpoint of the prospects for the development of the mineral resources.

Apart from aerophotopictures the geological deciphering requires the use of photoschemes and photoplans compiled at the scale of the flight and reproductions taken from them; the latter are reduced to a scale close to the scale of the executed exploratory works.

The methods for the analysis of the airplane pictures are based on a landscape approach to the deciphering operations which is a matter of great importance for the study of the poorly exposed areas. These analitical works provide for the study and careful examination of the connections between the relief and the geological substrate. The geoindicative significance of these relationships for the study of a concrete area is emphasized and the dependence of the relief forms upon the neotectonic movements is established in the coursea of investigations. The comples landscape deciphering permits to carry out geological mapping in the scarcely exposed and poorly accessible areas with a minimum of financial support usually required for the development of the drilling and the mining works.

This is of great importance for the study of areas with a developed system of enclosed oil fields. It is known that about 70% of the world's oil deposits is closely connected with the buried structures of the platform types bedded at considerable depths. Owing to this there has been elaborated a method for the exposure of the buried structures which is based on indirect characters which are deciphered on the aerophotopictures and has won wide acknowledgement. These characters are: the relief, the hydronetwork system, the general layout, the jointing, the tone of the photoreproduction, the distribution of vegetation etc.

This method has fully justified itself in the course of investigating the forest and the forest-steppe areas of the Ukraine and the Belorussia, the semidesert areas of the Western Kazakhstan and Turmenia etc.

The visual (qualitative) deciphering of the aerophotopictures under the stereoscope is accompanied by exact instrumental measurements. The designing, construction and the production of devices for these works is developed along the lines of their implementation by the geologists and, hence, enables to introduce these new techniques into the practice of routine field work.

Two of the more widely known and used devices deserve mentioning.

The most simple photogrammetric device is a 'paletka' (transparent sheet divided into squres) used by the geologist engaged in deciphering work (refer to fig.I). This device is portable and can be used in field work. It permits to measure the relative overlaps in locality sites making the best use of the aerophotopictures without using the stereoscope. These measurements are done with an accuracy of 1/500-1/700 of the altitude from which the picture was taken and permit to estimate the bedding elements (the strate) with an exactness which, as a rule, exceeds the accuracy of a mountain compass.

Measurements under laboratory conditions are carried out with the aid of a geological stereometer (fig.II). This device is intended for the solution of several problems: for the determination of elements of the rock bedding; the determination of the inclination angle of the slopes in the area; the estimation of the seam's thickness; the determination of the relative excess; the plotting of the exit projection onto the daylinght surface of the horizontal or the monocline dropping seam of the aeroplane picture. The accuracy in the determination of thickness and excessive characteristics noted in the geological stereometer amounts to 1/800-1/1000 of the altitude from which the photograph has been taken. The average quadratic arror in the course of measuring the angle of dip amount to ± 1.2° and the accuracy for the determination of the azimuth trend of seams with angles of dip exceeding 5° lies withnin the range of 3-50.

The geological charts compiled with a wide utilization of the results obtained from the deciphering operations are most exact in regard to the drawing and the substantiation of the contours and the expenditure of time required for this operation which is 1.5 times less than the time necessary for compling charts by using routine technique adopted for land mapping.

Aerophotography is most helpful for prospecting works.

The direct method for the exploration of deposits of commercial minerals incorporates the utilization of deciphering criteria involved with the variations of tone or colour in the aerial pictures; due account is also given to the specific forms of the relief. Thus, it is possible to reveal some minerals of commercial significance such as coal, iron and manganese ores and materials for construction works. In some cases, usually when deciphering coloured aerophotographic pictures, one can observe copper mineralization, iron hats covering the polymetal deposits, sites of developed weathered crust in the ultrabasite massives to which at times the nickel mineralization is attached and etc.

However, the indirect criteria for prospecting deciphering enjoy a much wider application. For example, with the aid of aerophotographic pictures one can trace the sites of

development of dikes and the fractures in the intrusions and other specific features noted in the structure of the granite plutons which may serve as key centres for the concentration of mineral wealth. Nonless frequently it is possible to decipher in detail the folded structures in the sedimentary formations. This fact is of great importance for the specialists working in the field of petroleum geology. When engaged in prospecting placer accumulations, during the period of preliminary laboratory deciphering there is a possibility, on the basis of the knowledge of the hydro-dynamic regime of the river, to single out the sites enriched with the minerals of the heavy fraction, to calculate the thickness of the pebble alluvium at a random area of the river-bed or flood plain and to carry out an expedient projection required for the further exploration and prospection. The application of the geobotanical methods to utilize vegetation as an indicator for chemical elements hidden beneath the soil-ground cover.

The use of the aerophotopictures for works dealing with geological prospecting introduces substantial corrections into the methods of these operations. Instead of applying the commonly used procedure i.e. ore manifestation--deposit area-ore field, the geologist has a possibility to review the vicinity of the investigated area during a comparatively short period of time and to trace whether there are in the adjacent sites areas which are structurally adherent to the one under examination; and having carried out a minimum number of routes acquire from the very beginning a uniform idea on the structure of the ore field as a whole. The application of the aerophotopicture technique permits to substitude the expensive and costly topographic and geolesic works devoted to the mapping of large-scale charts, which are based on the allocation of single marking horizons, mining exploration, drilling wells, points for geological and geophysical observations and to introduce cheaper and more efficient photogrammetric methods.

The tasks involved with the plotting of any fixed point traced on the aerial picture can be solved quite easily and with great precision.

Aerophotogra plays an exceptionally great role for studying the geological structure of the shallow water area of the sea bottom. The works in the area of the Caspian Sea that the aerophotographic pictures frequently permit to establish the substance content of rocks, to estimate the substance content of rocks, to estimate the conditions of their bedding, the form and the character of the foldings and and the fracture disorders. The aerophotographic pictures of the sea bottom is performed with the aid of orthochromatic aerophotographic films RF-I or RF-3 and with the use of dark-yellow filters when the position of the sun in regard to the horizon is not less than 15-20°. The aerial photographic survey should be performed preferebly under conditions of an entirely calm sea when the water transparancy is sufficiently high.

b) Soil research

In the course of soil mapping the deciphering of aerophotographic pictures maintains the basic technique adopted

for land works, but the scope of field work is considerably reduced, whereas the quality of the charts progressively improves. The aerophotographic pictures permit to accomplish a most complete analysis of the landscape components and their interrelations with the relief, vegetation, the difference of the moisture content in separate sites and numerous other details.

The deciphering begins with the singling out of soil contours according to tone differences and the change of the picture of photoreproduction. The determination of soils within the contour range is carried out during the establishment of causes responsible for the difference of photographic images. These causes are being revealed by means of land investigations along with the field deciphering of the aerophotographic pictures.

It has been established that the utilization of materials produced by the aerophotographic technique may be effectively applied to any types of landscapes both for compiling largescale and average-scale soil maps. The most efficient result is attained in the tundra, the dry steppe and desert zones. In the mentioned areas the labour efforts on behalf of the survey personnel and the efficiency of their work increases by 2-3 times. However, in the reforestated areas, as it is clear on the basis of revealing the indicative role of vegetation, the deciphering of soils and grounds can be accomplished most successfully. Similar works have been carried recently in the Belorussia and in the Ukraine.

Having used the vegetation as an indicator of the rate and character of soil and ground salinization in the arid areas there have been developed maps of salinization dynamics on the basis of decipher-ing technique. This work is of undoubtable significance for the development of the planning system in regard to the needs of farming in the newly cultivated areas.

The scaling of the aerophotographic survey works depends strongly upon the detailed mapping of the soil charts and ranges from 1:5000 to 1:25 000. The combination of the small-scaled surveys with the large-scaled-technique carried out along separate routes transversely to the run of the basic relief elements and also at the most complex areas or sites which are of some particular interest is viewed as a most useful method. The spring and autumn are regarded as the most favourable seasons for aerophotographic survey works and for agricultural areas it is best to carry out airplane photography during the period between ploughing and the rapid development of the herbs' sprouts. The coloured prints produced from the spectrozonal aerophotographic film reveals the highest efficiency for they permit to carry out soil deciphering more reliably and in greater detail.

c) Vegetation research

Aerophotographic pictures are most helpful for the study of the vegetation wealth and produce ample material for indicative geobotanical investigations. In the latter case geobotanical deciphering is being carried out as an obligatory auxilliary procedure in the course of geological, soil, hydrogeological and other types of exploring natural resources.

Aerophotographic technique is most widely applied for the study of the forest resources.

The initial materials for aerotaxation in cases of contourtopographic deciphering are the aerophotographic pictures with a scaling of 1:25 000 and more rarely of 1:15 000 - 1:10 000. The divisibility for the singled out areas changes respectively. The spectrozonal aerophotographic pictures produced during the summer months are used most frequently.

The forest taxation in the course of forest management is based upon the pictures into which the boundaries of the taxative areas are introduced afore and the topographic base is deciphered. For the purpose of forest management according to the Ist and 2nd categories it was found advisable to adopt the following scaling for aerophotographic pictures 1:10 000- 1:15 000 and the 3rd and 4th category requires 1:20 000 - 1:30 000. The stereophotogrammometric measurements permit to determine the height of the trees and the width of the tree top with an average quadratic error of 10-13%.

The availability of aerial pictures enables to reduce the scope of the land work and most accurately map the boundaries of different types of woods and to hasten the production of maps. Aerophotographic technique opens wide possibilities for the study of the state of forests throughout various seasons.

The landscape method of deciphering based on a sequential singling out of progressively smaller territorial units is applied for the study of vegetation in the steppe, semi-desert and desert areas. This method permits, within the limits of a restricted area, to obtain an adequately substantiated boundary line between the distinguished areas, to dismember the vegetation groups to the formations or group accociations, to reveal the types of pasture grounds and the farming lands. The prearranged method for deciphering landscape-analogues permit to use the materials produced for certain areas for the study of other territories which reveal similar landscape features. Thus, it is possible to explore pasture grounds, haymaking areas etc.

Aerophotographic technique proves to be the sole method for the investigation and the estimation of vegetation resources hidden in seas for only this method is liable to produce the true contours for tracing the growth areas of algae in the shallow water zones and the areal distribution of the phytobenthos. In this case the deciphering is accomplished by the method of key-analogues with a due account of the specific features of the sea bottom and the water environment. Aerophotographic surveys are carried out in relation to natural conditions and may be done on orthochromatic, panchromatic or spectrozonal films.

d) The study of water resources

In the course of hydrogeological and hydrological investigations the analysis of the aerophotographic pictures frequently produces such results which cannot be attained by any other techniques.

The solution of problems involved with water supply in the arid areas where the water wells are fed with fresh and slightly salted waters is accomplished basically at the cost of leakage water and the assistance of aerial photography in this case is hard to overestimate. The technique for revealing leakage water lenses is implemented on the basis of establishing relations between the latter and the shape of the landscape (relief) and the rock lithology and the reflection of this connection in the vegetation cover. The subsequent deciphering of the freshwater lenses is carried out by applying the method of key-analogues.

Aerophotographic surveys for hydrogeological purposes in the arid areas is carried out during the period of utmost differences noted in the phreatophyte communities in regard to the spectrozonal film. Having taken into consideration the size of the leak-age water lenses, which is frequently insignificant, the optimum scale of aerophotographic pictures is 1:10 000-1:15 000.

The study of surface waters showed long ago that no kind of land survey examinations is able to cover all the intricate twists of the water flows. Aerophotographic survey technique has solved this problem in a very easy and simple way and has provided man with maximum knowledge concerning the distinct traits of the water surface and has also permitted to reconstruct its contours throughout different epochs and to forecast the further changes of the coastline. Having applied the photometric method up to the depth of 5 m. one may estimate the depth of the basin with adequate accoracy according to the image tone of the bottom. The production of formulas for the careful consideration of the distortions which may have appeared in the representation of the submarine relief has enabled to estimate the depth of the basin and this has been accomplished by means of the stereophotogrammometric technique.

The new possibilities for obtaining the basis characteristics of the aquatic objectives are combined with the routine methods. On one hand, they appear as objective control tests and, on the other hand, they permit to carry out various sorts of interpolations and extrapolations when the land observations are next to minimum and can be used as reference guides.

x x

x

The numerated problems doubtlessly cover all the possible aspects for the application of aerial photography for the purpose of studying and exploiting the natural resources. This method is very handy for the study of the ice regime, for the projection of railroads and highways, pipe lines, lines for the transmission of electric energy etc. The methods for conducting aerophotographci surveys for various economic purposes and the utilization of this method for the solution of concrete problems has been develpped at a high rate in the USSR and is progressively advancing in the course of each following year. The main tendency lies in the further improvement and perfection of this technique which will enable it to explore the less known and remote areas.

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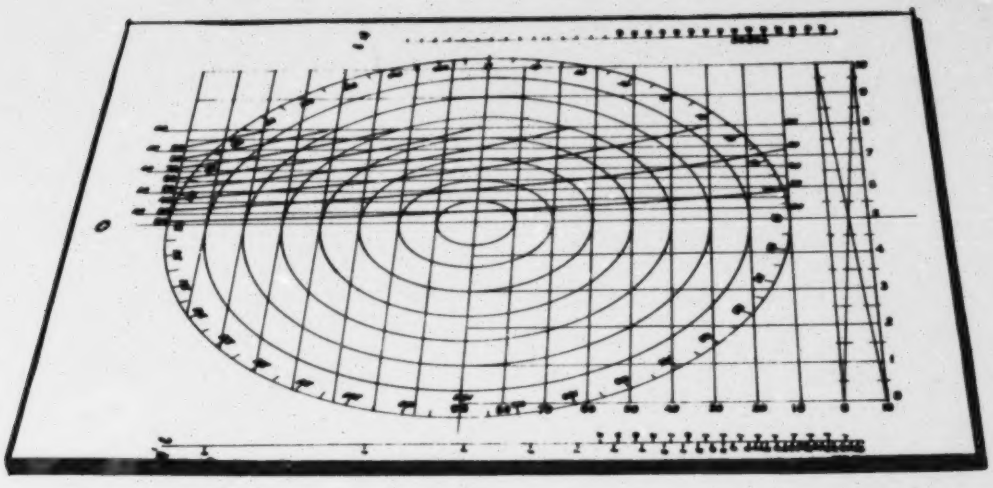

Fig. 1

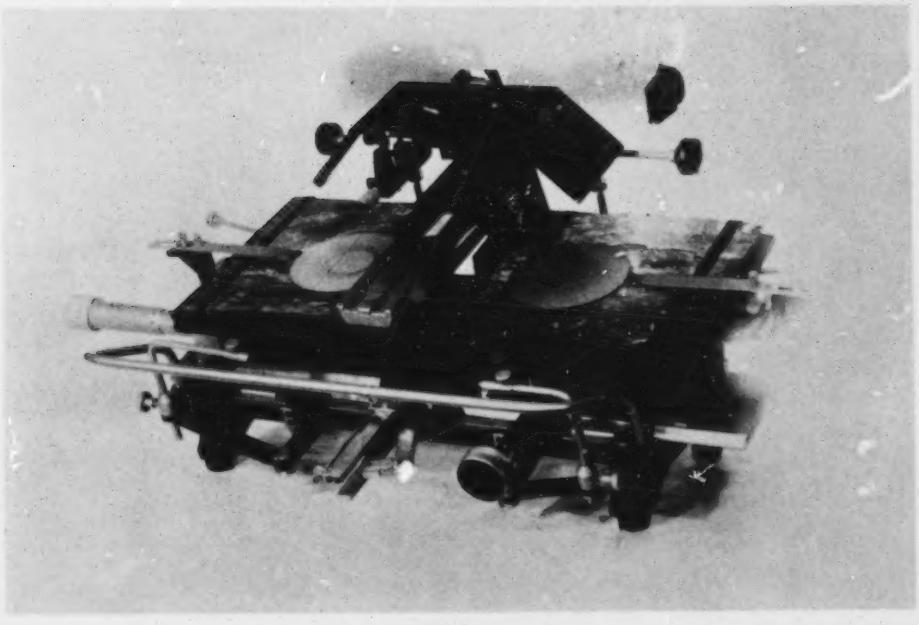

Fig. 2

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